TCP Friendly Rate Control (TFRC): Protocol Specification
RFC3448bis

draft-ietf-dccp-rfc3448bis-02.txt
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Reported in previous IETFs:

• Changes from RFC 3448, in draft-ietf-dccp-rfc3448bis-00.txt
• Changes in draft-ietf-dccp-rfc3448bis-01.txt
• Reported for me in March 2007:
  – A slide on “things that could be done”.
Changes from draft-ietf-dccp-rfc3448bis-01.txt:

- The initial feedback packet after an idle period.
  - The mechanism for dealing with this has changed.
- Response to idle and data-limited periods.
  - The sender is not limited by the receive rate if the sender has been idle or data-limited for an entire feedback interval.
- Use of unused send credits:
  - The sender may keep unused sent credits up to one RTT.
- Many clarifications and some small changes, listed in the draft.
The initial feedback packet after an idle period:

• The mechanism for dealing with this has changed.
• The new mechanism:
  – Keep $X_{\text{recv}}$ set, with $X_{\text{recv}}$ from the last two RTTs.
  – If (the entire interval covered by the feedback packet was a data-limited interval)
    • Replace $X_{\text{recv}}$ set contents by Infinity;

• Older mechanisms in older revisions:
  – If (not the first feedback packet, and not the first feedback packet after a nofeedback timer)
  – If (feedback packet reports Limited Receive Rate or sender has been data-limited over period covered by the last feedback packet)
Response to Idle and Data-Limited Periods:

<table>
<thead>
<tr>
<th>Protocol</th>
<th>Long idle periods</th>
<th>Long data-limited periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard TCP:</td>
<td>Window -&gt; initial.</td>
<td>No change in window.</td>
</tr>
<tr>
<td>TCP with CWV:</td>
<td>Halve window (not below initial cwnd).</td>
<td>Reduce window half way to used window.</td>
</tr>
<tr>
<td>Standard TFRC:</td>
<td>Halve rate (not below 1 pkt/64 sec). One RTT after sending pkt, rate is limited by X_recv.</td>
<td>Rate limited to twice receive rate.</td>
</tr>
<tr>
<td>Revised TFRC:</td>
<td>Halve rate (not below initial rate).</td>
<td>Rate not limited to twice receive rate.</td>
</tr>
</tbody>
</table>
Response to Idle Periods:

• The initial version of RFC3448bis:
  – After a long idle period, the sender doesn’t reduce the allowed rate below the initial rate.
  – From RFC4342.

• This is still true.
  – But the mechanisms have changed.
Response to Idle Periods:

• **Current pseudocode:**
  – If \(X_{\text{recv}} < \text{recover\_rate},\) and sender has been idle ever since nofeedback timer was set
    • Don't use \(X_{\text{recv}}\) to reduce sending rate.

• **Initial versions of the draft (-00 and -01):**
  – The code for dealing with idle or data-limited periods was in response to feedback packets, not in response to the nofeedback timer.
  – If (sender has been idle or data-limited)

• **Later versions of the draft (-02c):**
  – The code for dealing with idle or data-limited periods was moved to be in response to the nofeedback timer (as it is now).
  – If \(X_{\text{recv}} < 4\) packets per round-trip time, and sender has been idle since nofeedback timer was set
    • Don’t use \(X_{\text{recv}}\) to reduce sending rate.
Response to Data-Limited Periods:

• This draft:
  – Follow **Standard TCP**, and don’t be limited by receive rate during data-limited periods.
  – If (the entire interval covered by the feedback packet was a data-limited interval) \{ 
    Replace X_recv_set contents by Infinity;
  \}

• Earlier -00, -01, and -02c revisions:
  – During idle or data-limited periods, **do be limited by receive rate, but not below the initial sending rate.**
  – If (sender has been idle or data-limited within last two round-trip times)
    \[
    \text{min\_rate} = \max(2 \times X_{\text{recv}}, W_{\text{init}}/R);
    \]
Unused send credits:

• Specified that the sender may maintain unused sent credits up to one RTT.
  – This gives behavior similar to TCP.
  – A TFRC implementation MAY limit bursts to less than one RTT, if desired.

• This was not explicitly addressed in RFC 3448, or in earlier revisions of this draft.
Basic Simulation Results - I

- Long idle period behaviour.
- Sending rate never reduces below recover_rate
- Low receiver rate after idle period and initial startup rectified.

Bottleneck link = 10 Mbps, 300 ms; Sender sending at 50 pps, 160 bytes packets; Idle sender between 10s and 20s.
Basic Simulation Results - II

• Long idle period behaviour.
• With loss, the sending rate is limited by the throughput equation after the idle period.

Bottleneck link = 10Mbps, 300ms; Sender sending at 50 pps, 160 byte packets; Idle sender between 10s and 20s. Loss = 10%, uniformly distributed
Basic Simulation Results - III

- **Data limited behaviour**
- Low receiver rate problem rectified.
- 3448-bis now good for bursty traffic: gives high perceived quality.

**Bottleneck link = 6Mbps, Varying delay; Sender sending at 50 pps, 160 bytes packets; Varying Burst and Idle Parameters**
Change #1 to make:

• For reducing sending rate during idle periods during initial slow-start.

• Old:

   Else if (X_recv < recover_rate, and
           sender has been idle ever since nofeedback timer was set)
       Timer_limit is not updated;

• New:

   Else if (((p>0 && X_recv < recover_rate) or
              (p==0 && X < 2 * recover_rate)), and
              sender has been idle ever since nofeedback timer was set)
       Timer_limit is not updated;

Problem reported by Arjuna. (Fix not yet tested.)
Change #2 to make:

- When datalimited and p = 0, the sender still doubles the allowed sending rate after each feedback packet.
- Old code, for when (p==0):
  
  ```
  Else if (t_now - tld >= R)    // initial slow-start
    X = max(min(2*X, recv_limit), initial_rate);
    tld = t_now;
  ```
- New code, for when (p==0):
  
  ```
  Else if (t_now - tld >= R) and
    (sender was not data-limited over entire feedback interval)
    // initial slow-start
    X = max(min(2*X, recv_limit), initial_rate);
    tld = t_now;
  ```

Problem reported by Arjuna. (Fix not yet tested.)
Future work (in a separate document):

• “Future work could explore alternate responses to using the receive rate during a data-limited period.”
  – E.g., more like TCP with Congestion Window Validation.

• At a minimum, we could have more limits on *increasing* the allowed sending rate during a data-limited period.